Pearson BTEC Sample Set Assignment Brief

Single-Part Assessment

Unit 1 – Mechanical Principles

For use with:

Pearson BTEC International Level 3 qualifications in Engineering

Certificate (Optional)/Subsidiary Diploma (Optional) Foundation Diploma/Diploma/Extended Diploma

Advised supervised hours	2 hours

For completion by the centre

Qualification (select as appropriate)	Certificate/Subsidiary Diploma/Foundation Diploma/Diploma/ Extended Diploma
Assessment date	

Pearson BTEC

Instructions to tutors and/or invigilators

The Pearson Set Assignment will be assessed internally by the centre, using the unit assessment criteria given in the qualification specification. The Set Assignment will be sampled by the Standards Verifier as part of the annual standards verification centre visit.

Conditions of supervision

The Pearson Set Assignment should be undertaken in conditions that assure the authenticity of outcome. This may require supervision.

We advise that the Pearson Set Assignment be completed in sessions that come to a total of 2 hours. The Pearson Set Assignment should not be shared with learners prior to the start of the assessment period. Teachers/tutors are responsible for security of the Pearson Set Assignment and materials.

Outcomes for submission

Learners may submit handwritten or word-processed evidence. Drawings and diagrams must be completed in pencil.

Learners will need to have access to a non-programmable calculator that does not have the facility for symbolic algebraic manipulation or to allow the storage and retrieval of mathematical formulae.

Learners will need access to the Information Booklet of Formulae and Constants.

Learners must submit their own, independent work as detailed in the Set Assignment. Each learner must complete an authentication sheet.

Instructions to learners

Read the Set Assignment carefully.

You will be asked to carry out specific activities using the information provided. You will be given a specific time period to complete the assignment.

You must work independently at all times and must not share your work with other learners. You must complete an authentication sheet and submit it along with your work.

You should show all of your working when completing calculations.

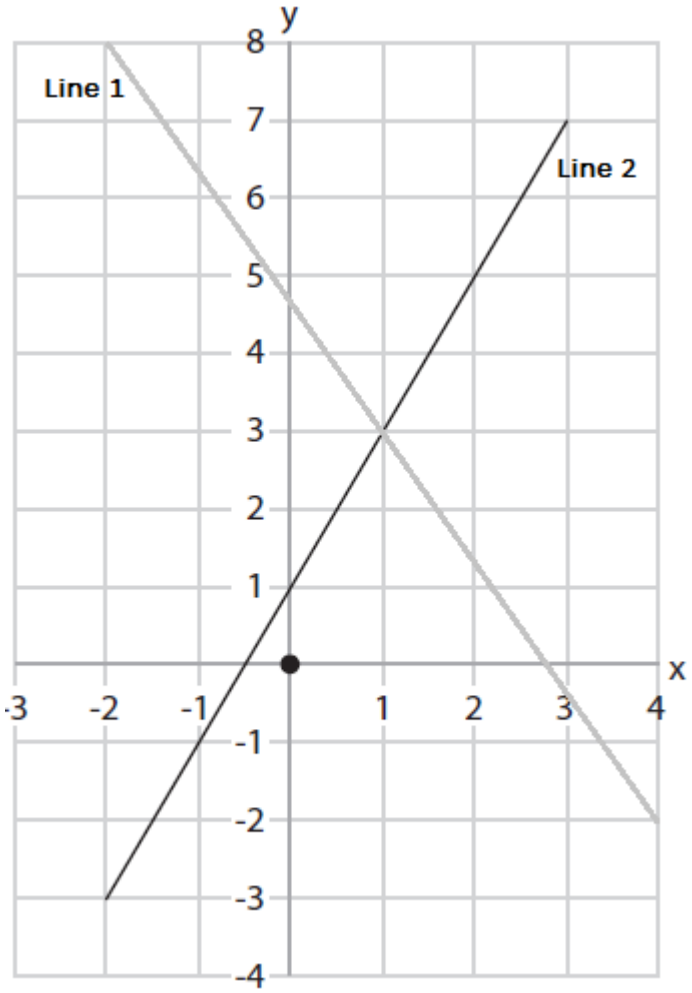
Set Assignment

You must complete ALL activities.

We advise that you spend 2 hours.

ACTIVITY 1

1. The graph shows the results of two engineering investigations:

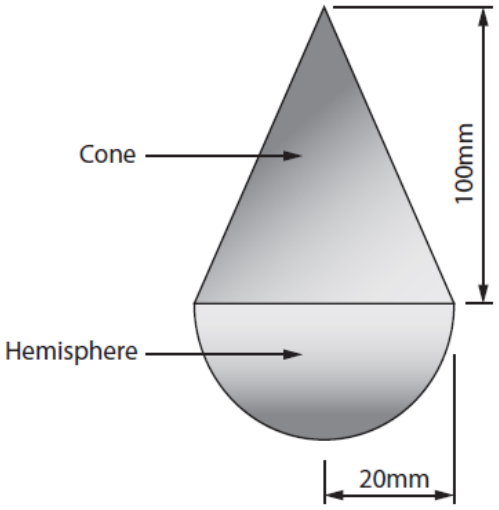


(a) From the graph, find the intersection of line 1 and line 2.

(b) Use the graph to find the value of the gradient of line 1.

(c) Use the graph to find the value of the gradient of line 2 and hence the equation of the line.

2. The image shows a plumb bob made from an unknown material.



(a) Calculate the length of the side of the cone.

(b) Calculate the total surface area of the plumb bob.

(c) The cost of manufacturing a plumb bob can be calculated using the formula:

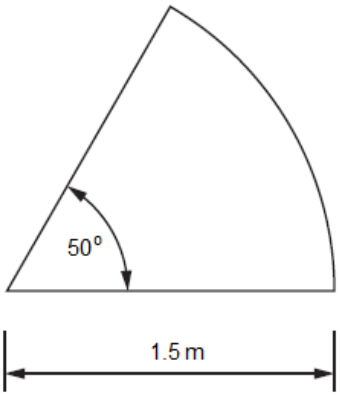
Cost = $10t^2 + 4mt + 2t$

Where t is the time taken (in seconds) for machining the plumb bob and m is the cost of the material.

Simplify the expression in its simplest form.

(d) If the overall cost of manufacturing one plumb bob is 12 and the cost of the material is 2, calculate the amount of time taken to manufacture one plumb bob.

3. A piece of plate metal has been cut to make a platform to link two walkways.



Use the information in the diagram to find:

(a) the area of one side of the plate

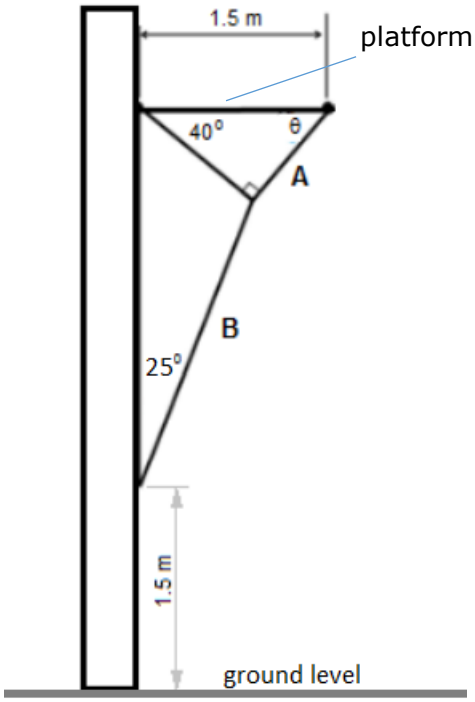
(b) the length of the curved edge of the plate

(c) the total length of the edges of the plate.

The plate metal is 25 mm thick.

(d) Calculate the volume of the platform.

The platform has supports that are fixed to both a wall and the ground, as shown.



Using the information in the diagram, you need to calculate:

(e) the angle θ

(f) the length of side A

(g) the length of side B

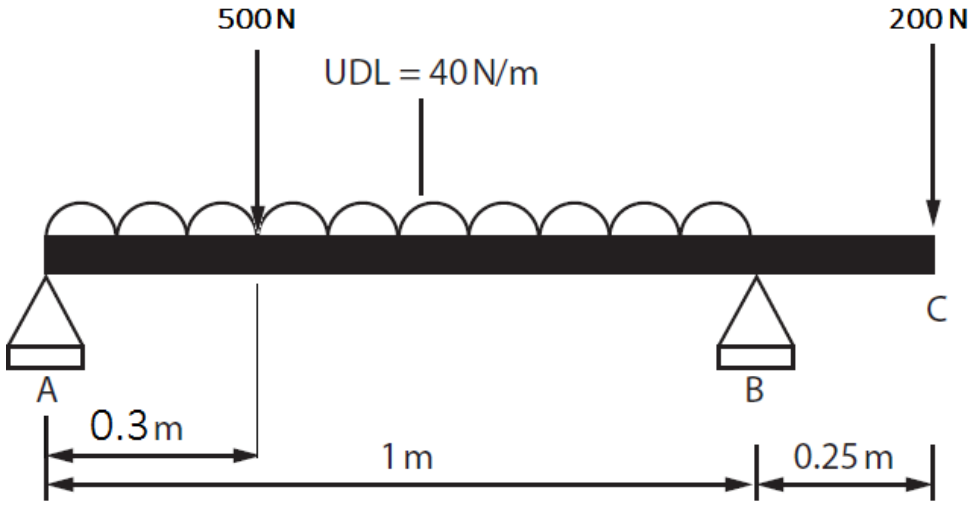
(h) the height above the ground of the platform.

This activity covers learning aim A and assessment/grading criteria:

A.P1, A.P2, A.M1, A.D1

ACTIVITY 2

1. The diagram shows a simply supported beam. The beam is in equilibrium.

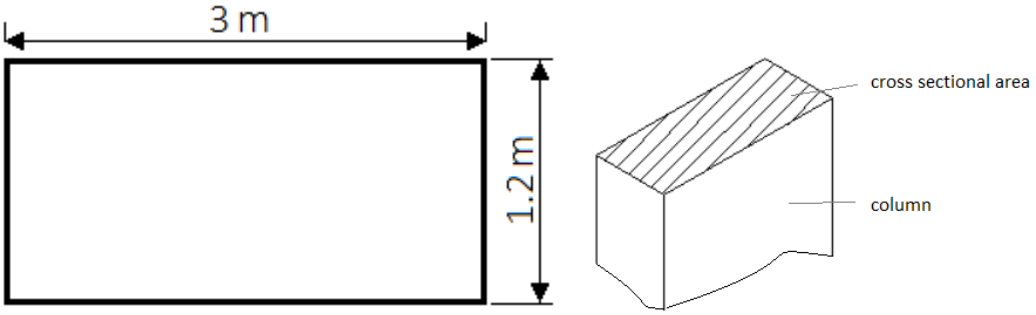


Using the information in the diagram, calculate:

(a) the loading on the beam that results from the UDL

(b) the reaction forces at points A and B.

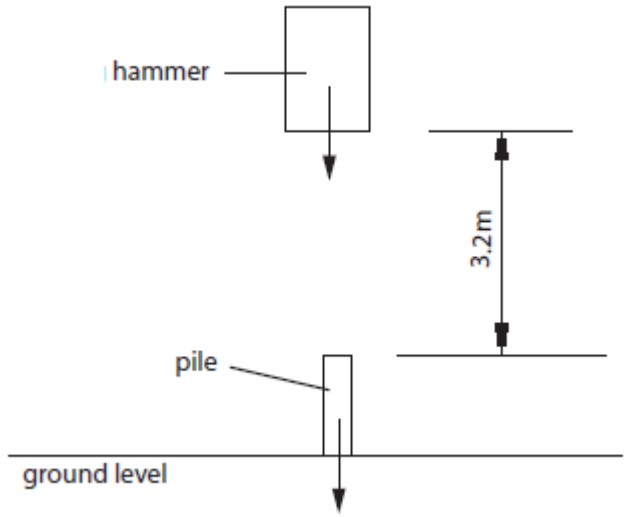
The beam is supported on two columns at points A and B as shown. The cross-sectional area of each column is shown below.



(c) Calculate the direct stress in column A as a result of the loading.

(d) Explain what would happen to the beam if the load at point C was increased to 20 kN.

2. The diagram shows a hammer that is dropped onto a pile.



The hammer is released from rest.

(a) Calculate the velocity of the hammer when it hits the pile.

(b) Calculate the kinetic energy of the hammer when it hits the pile.

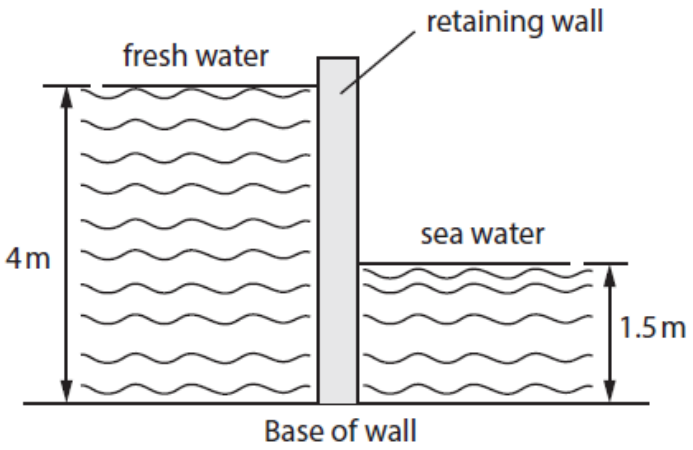
The hammer has a mass of 500 kg and the pile has a mass of 290 kg.

The hammer does not rebound when it hits the pile.

(c) Calculate the velocity of the pile immediately after the hammer hits it.

(d) Calculate the resistive force of the ground if the pile is driven 150 mm into the ground.

3. A retaining wall is used to separate sea water from fresh water.



The retaining wall is 12 m wide.

Assume the density of sea water is 1030 kg/m^3 and the density of fresh water is 1000 kg/m^3.

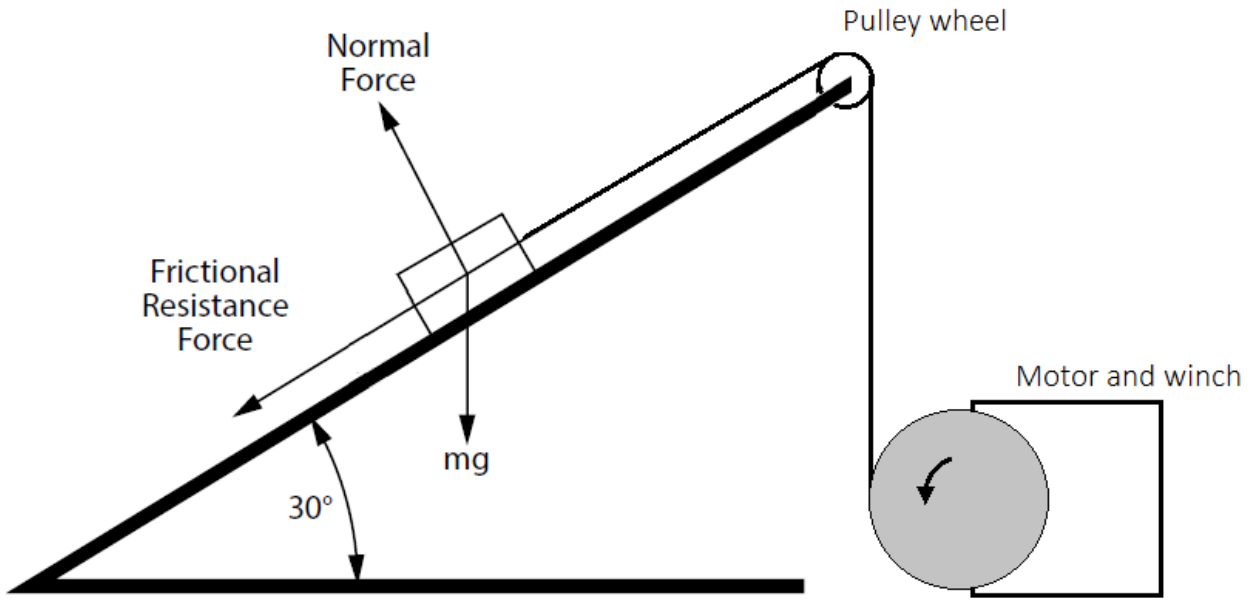
(a) Calculate the resultant overturning moment of the wall about its base.

A cylinder of an unknown material is floating in the fresh water.

The cylinder has a volume of 1.2 m^3. 5 kg of water are displaced by the cylinder.

(b) Calculate the density of the unknown material.

4. The diagram shows a load being raised by a motor and winch.



The original length of the rope between the load and the motor is 4.8 m. When the motor starts to turn, the rope stretches to 4.92 m.

(a) Calculate the strain in the rope.

The coefficient of friction of the slope is 0.2. The mass of the load is 375 kg.

(b) Calculate the frictional resistance force.

(c) Calculate the work done in moving the load 1.8 m along the slope.

(d) The angle of the slope is changed to 25°. Explain how this would affect the frictional force.

This activity covers learning aims B, C and D and assessment/grading criteria:

B.P3, B.P4, B.M2, C.P5, C.P6, C.M3, D.P7, D.P8, D.M4, BCD.D2

Pearson BTEC Level 3 International Qualifications in Engineering

Engineering

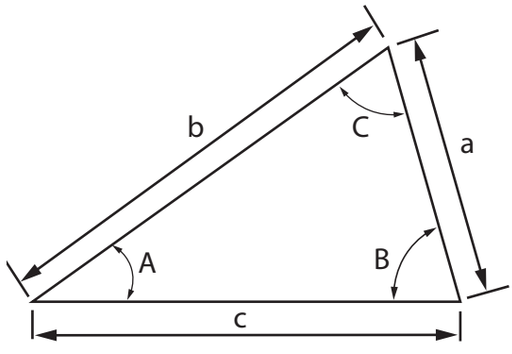
Unit 1: Mechanical Principles

Source Booklet of Formulae and Constants

Formulae and Constants

Maths

Trigonometric rules



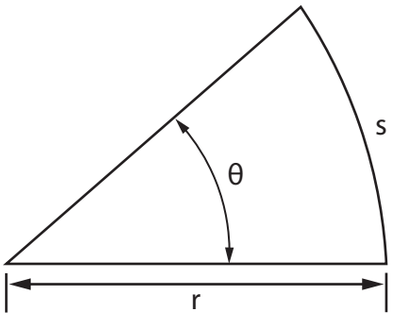
Sine rule

$$\frac{a}{\text{Sin } A} = \frac{b}{\text{Sin } B} = \frac{c}{\text{Sin } C} \text{ or } \frac{\text{Sin } A}{a} = \frac{\text{Sin } B}{b} = \frac{\text{Sin } C}{c}$$

Cosine rule

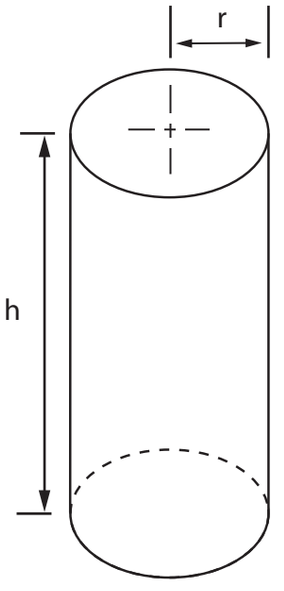
$a^2 = b^2 + c^2 - 2bc \text{ Cos } A$

Volume and area of regular shapes



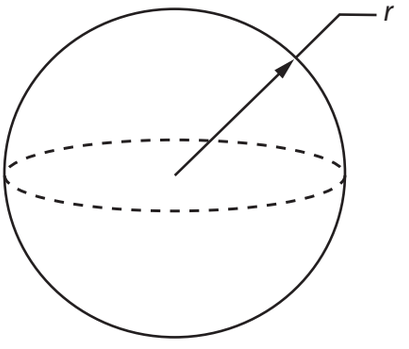
Length of an arc of a circle $s = r\theta$ (where θ is expressed in radians)

Area of a sector of a circle $A = \frac{1}{2} r^2\theta$ (where θ is expressed in radians)



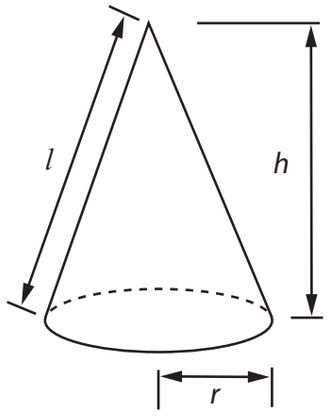
Volume of a cylinder $V = \pi r^2 h$

Total surface area of a cylinder $TSA = 2 \pi rh + 2 \pi r^2$



Volume of a sphere $V = \frac{4}{3} \pi r^3$

Surface area of a sphere $SA = 4 \pi r^2$



Volume of a cone $V = \frac{1}{3} \pi r^2 h$

Curved surface area of cone $CSA = \pi r l$

Quadratic Formula

To solve $ax^2 + bx + c = 0$, $a \neq 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Physical constants

Acceleration due to gravity $g = 9.81 \text{m/s}^2$

Equations of linear motion with uniform acceleration

v = final velocity, u = initial velocity, a = acceleration, t = time and s = distance

$v = u + at$

$s = ut + \frac{1}{2} at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}$ (u + v)t or $s = \frac{u + v}{2} t$

Stress and strain

Direct stress	$\sigma = \frac{F}{A}$
Direct strain	$\varepsilon = \frac{\Delta l}{l}$
Shear stress	$\tau = \frac{F}{A}$
Shear strain	$\gamma = \frac{a}{b}$
Young's Modulus (modulus of elasticity)	$E = \frac{\sigma}{\varepsilon}$
Modulus of rigidity	$G = \frac{\tau}{\gamma}$

Work, power, energy and forces

Force	$F = ma$
Components of forces	$F_x = F\cos\theta$, $F_y = F\sin\theta$ Where θ is measured from the horizontal
Mechanical work	$W = Fs$
Mechanical power	$P = Fv$, $P = \frac{W}{t}$
Mechanical Efficiency	$Efficiency\ (\eta) = \frac{P_{out}}{P_{in}}$
Force to overcome limiting friction	$F = \mu N$ (where N is the normal force)
Gravitational potential energy	$PE = mgh$
Kinetic energy	$KE = \frac{1}{2} mv^2$

Angular parameters

Centripetal acceleration	$a = \omega^2 r$ or $a = \frac{v^2}{r}$
Power	$P = T\omega$
Rotational inertia	$I = k m r^2$ The inertial constant for a solid cylinder (flywheel) $k = \frac{1}{2}$ and for a thin walled hollow cylinder $k \approx 1$ (along the axis of rotation).
Rotational kinetic energy	$KE = \frac{1}{2} I\omega^2$
Angular frequency	$\omega = 2\pi f$
Frequency	$f = \frac{1}{time\ period}$
Radians to degrees conversion	$\theta_{(degrees)} = \frac{360\ \theta_{(radians)}}{2\pi}$ where 2π radians = 360°
Degrees to radians conversion	$\theta_{(radians)} = \frac{2\pi\ \theta_{(degrees)}}{360}$

Fluid principles

Continuity of volumetric flow	$A_1 v_1 = A_2 v_2$
Continuity of mass flow	$\rho A_1 v_1 = \rho A_2 v_2$
Hydrostatic thrust on an immersed plane surface	$F = \rho g A x$
Density	$\rho = \frac{m}{V}$

Marker Sheet – Routine/non-routine requirements

This Marker Sheet should be used in conjunction with Unit 1. This sheet indicates whether a learner solution should be using routine or non-routine methods. These terms and their application are explained in the Unit 1 *Essential Information for Assessment Decisions* section.

ACTIVITY 1

Question		Type
1	(a)	routine
	(b)	routine
	(c)	routine routine
2	(a)	non-routine
	(b)	non-routine
	(c)	non-routine
3	(a)	routine
	(b)	routine
	(c)	routine
	(d)	routine
	(e)	routine
	(f)	non -routine
	(g)	non-routine
	(h)	non-routine